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Assessment of sustainability of agriculture water management from the perspective of Wheat farmers in villages of Maragheh City in Iran

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ABSTRACT

The present study aims to evaluate the sustainability of water resources management among wheat farmers in the villages of Maragheh City in Iran. This study is applied research conducted using a survey method. The statistical population includes all irrigated wheat farmers in Maragheh City (N=240). According to Krejcie and Morgan's table, the statistical sample size is estimated to be 149. The samples are selected using the stratified sampling method. A correlation test and a multiple regression analysis are used to analyze the data and the Radar is used to assess the sustainability of agricultural water resources management. The results indicate that there is a direct and significant relationship between the farmers' application of measures related to sustainable water resources management and their attitudes toward sustainable water resources management, agronomic, economic, educational-extensional, policy-making, and institutional factors, the area under cultivation, and income. Moreover, there is an inverse and significant relationship between the farmers' application of measures related to sustainable water resources management and membership in rural organizations. The results of multiple regression analysis, which is used to investigate the effects of the independent variable on the dependent variable (the application of measures related to sustainable water resources management in agriculture) show that five variables of economic, educational-extensional, social, and agronomic factors and farmers' attitudes toward sustainable water resources management explain about 63% of the variance of the dependent variable. From the perspective of irrigated wheat farmers in Maragheh City, the sustainability of agricultural water resources management is evaluated to be at a moderate level according to the total scores obtained for them.

Key words: Agriculture, Development, Management, Sustainability, Water scarcity crisis

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1. INTRODUCTION

Water, as a constituent of the environment, an essential element for life and also a fundamental component for any development model, is at the core of sustainable development. In the last few years, human activities have led to serious and irreparable damage to this valuable limited resource, and its quantity and quality have deteriorated sharply in many societies. Research by the International Water Management Institute showed that by 2025, most of the world's population may face a freshwater crisis (Mirzaei *et al*. 2015). Such a situation is even worse for countries in the Middle East, such as Iran, which are among the arid and semi-arid regions of the world and have limited water resources. The average annual precipitation in the Middle East and Iran is 217 and 228 mm, respectively, which is less than one-third of the world's average annual precipitation. Iran, with a population of about 80 million people (about one percent of the world's population, enjoys only 0.3% of the world's freshwater resources. The study of water scarcity metrics, including renewable water resources per capita and water stress, in Iran, implies the start of severe water scarcity in it. The world's renewable water resources per capita is 6079 m^3, but due to the disproportionate distribution of these resources, the Middle East region with a per capita of 1559 m^3 is in critical condition. In 2016, Iran's renewable water resources per capita equaled 1450 m^3 and it is predicted that this number will reach 1049 m^3 in 2041 (Development and Foresight Research Center of Iran's Planning and Budget Organization 2017). Also, the results of research by the Food and Agriculture Organization in 93 developing countries showed that water storage is declining in them, while it is impossible to replace resources and 10 countries, including Iran, are in the water crisis. Therefore, it can be concluded that Iran is currently in the stage of water stress. In Iran, the agricultural sector is one of the most important economic and social sectors and the largest water user. The study of water consumption by main sectors shows that in most parts of the world (except Europe and the United States), the agricultural sector is the largest water user. In the Middle East and Africa, the agricultural sector accounts for 84% and 82% of the water consumption, respectively, and it is 92% in Iran (FAO 2011). In recent years, due to climate change and poor water resources management, the sector has faced a water crisis. As mentioned, in Iran, the average annual precipitation is about 228 mm, which is less than one-third of the world's average annual precipitation. Out of this amount, 75% of precipitation takes place out of the wet season and it is not possible to apply it in agriculture. This issue, along with the excessive and uncontrolled exploitation of surface water and groundwater resources, climate change, and inefficient water resources management, has led to the water crisis, especially in the agricultural sector. According to Iran's Forests, Range, and Watershed Management Organization, more than two-thirds of lands in Iran are rapidly becoming desert, and about 31.5 million hectares of arable lands in Iran are not cultivated, due to water shortages (Tajeri Moghadam 2018). Meanwhile, the demand for water, Iran's population, food imports, and inflation have increased. Studies indicated that in Iran, water shortage in the agricultural sector is not only due to climate change, but also significantly implies the key roles of human factors, poor water resources management, and lack of plans or implementation of incorrect programs. Out of water consumed in the agricultural sector, 40% is wasted due to inefficient management and the use of traditional irrigation methods (Panahi *et al*. 2012). Investigating the changes in consumption and discharge of groundwater resources by different agricultural, industrial, and drinking water sectors during the last 15 years in Iran shows that the average groundwater resources harvested for the three sectors aforementioned is 50, 5, and one billion m^3, respectively. It is noteworthy that the discharge and consumption of groundwater resources are decreasing, due to the fact that groundwater resources have reached their maximum water yielding capacity (Office of Basic Studies of Water Resources, Iran's Ministry of Energy 2017). The irregular harvesting of water resources has increased to such an extent that about 355 of 609 plains in Iran have been critically banned, while in 1968, there were only 15 banned plains. In some plains, the continuous decline of groundwater resources and lack of water supply caused many fertile lands to remain unused and many gardens to be destroyed (The detailed document of Iran's Sixth Development Plan 2017). The continuation of this situation has provided the impossibility of living in some parts of Iran, in addition to reducing the production capacity of agriculture. In the last 40 years, 32,000 villages and hamlets in Iran have been evacuated. The number of villages in Iran has decreased from about 92 thousand in 1976 to 60 thousand in 2016 (Eidi and Kazemiyeh 2020). One of the main reasons for this evacuation of villages is water shortage and the loss of agriculture and related jobs. Therefore, it can be concluded that if there is no coherent and systematic plan for sustainable water resources management, especially in the agricultural sector, where the highest consumption and water shortage take place, there will be irreparable consequences for the country.

The concept of sustainable water resources management in agriculture has emerged in response to the improper use of water resources and its destructive environmental and economic effects. In fact, sustainable water management is a way to enable farmers and water users to meet their needs without compromising the ability of future generations to meet their own needs. In other words, sustainable water resources management is a set of activities for planning, development, distribution, and management of optimum use of water resources so that they are efficiently and equitably distributed between their users and the present and future generations' benefits are provided from water exploitation in related social, economic and environmental areas. Due to the importance of the issue, the present study aimed to evaluate the sustainability of the agricultural water resources management (case study: irrigated wheat farmers in Maragheh City). This study provided a relatively clear understanding of the sustainability of agricultural water resources management in Maragheh City and its results can be used by all managers, policy-makers, decision-makers, and planners in this field in different organizations. Various domestic and foreign studies have evaluated the sustainability of agricultural water resources management and examined the factors affecting it, some of which are described below.

Levner *et al*. (2008), in their study, have examined sustainable water resources management and minimization of environmental risks. The results have indicated that developing a sustainable water resources management model requires attention to economic, physical, infrastructure, and social conditions where water is used in different areas. In a study, the Organization for Economic Co-operation and Development (OECD) (2010) has shown that sustainable water resources management in agriculture covers a wide range of agricultural systems and activities (including managerial, agricultural, and technical) and is influenced by numerous variables and factors including political, cultural, economic, social, regional and financial factors and institutional and legal contexts. In addition, climatic variability, especially seasonal problems such as changes in the timing of annual rainfall patterns or snowmelt periods, were other major factors affecting agricultural water resources management. Kulmatov (2014) has studied the problems of sustainable management and use of water resources in Uzbekistan. The results indicated that mismanagement, use of outdated technologies, low level of knowledge and awareness of farmers, lack of relevant training courses, and insufficient government support were the most important problems in sustainable water resources management. Chartzoulakis and Bertak (2015), in their study on sustainable water resources management under climate change, have shown that agricultural activities such as soil management, reduced application of fertilizer, and disease and pest control are related to sustainable water management in agriculture and protection of the environment. Moreover, the results indicated that the acceptance of sustainable water management is not only a technological issue but also includes other considerations, especially the social behavior of rural communities, empowerment and participation of farmers in water management, economic constraints, and common institutional-legal framework in an area. Afshari (2016), in a study, has analyzed the factors explaining the actions related to sustainable water resources management in agriculture in Komijan city. The results have indicated that the five management, agricultural, technical, control, and maintenance and restoration factors explained about 66% of the variance of actions related to sustainable water resources management in agriculture. In another study, Shafiee *et al*. (2017) have identified the challenges and requirements affecting optimal water resources management in agriculture in Mazandaran province. Their findings have shown that the most important challenges of the optimal water resources management in agriculture in the study area include not choosing a cropping pattern appropriate to the climate of the region and not using modern irrigation systems. Moreover, the most important requirements include the use of agricultural mechanization and modern irrigation methods and attention to the role of agriculture education and extension.

2. MATERIALS AND METHODS

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The present study is applied research in which data were collected using a field survey. It aimed to assess the sustainability of agricultural water resources management (case study: wheat farmers in rural areas of Maragheh City). The statistical population included all irrigated wheat farmers in Maragheh City (N = 240). According to the report by the Jihad-e Agriculture Organization (JAO) of Maragheh, there are 240 irrigated wheat farmers working in five villages of Ahaq, Khanqah, Hajikord, Khorma Zard, and Serej. According to Krejcie and Morgan's table, the statistical sample size was estimated to be 149. The sample farmers were selected using the stratified sampling method. The data were collected using a researcher-made questionnaire. The primary questionnaire was designed according to the research purpose as well as the research background and literature. Then, the final questionnaire was developed considering the opinions of professors, experts of the Jihad-e Agriculture Organization and the Regional Water Organization, as well as field surveys in the study area, and its content validity was confirmed. To evaluate the reliability of the research instrument, 30 questionnaires were filled out and Cronbach's alpha value was calculated for each of its parts (Table 1).

Table 1 Cronbach's alpha calculated for each section of the questionnaire.

	Cronbach's alpha
Actions related to sustainable management of agricultural water resources	0.86
Farmers' attitudes towards sustainable management of agricultural water resources	0.71
Agronomic factors	0.86
Economic factors	0.78
Social factors	0.74
Educational-extensional factors	0.74
Policy and institutional factors	0.73

As seen, Cronbach's alpha values ranged from 0.71 to 0.86, indicating the desired reliability of the research instrument. To assess the application of activities related to sustainable management of agricultural water resources (dependent variable), farmers were asked to determine, based on a five-point Likert scale (from too little = 1 to too much = 5), to what extent they apply 26 activities related to sustainable management of water resources during the past years. Moreover, independent variables including individual/family, agricultural, economic, social, educational-extensional, policy, and institutional factors and farmers' attitudes towards sustainable management of agricultural water resources were assessed based on a five-point Likert scale. Data analysis was performed using $SPSS_{22}$ software, correlation test, and multiple regression analysis. Also, the Sustainability Radar was used to assess the sustainability of agricultural water resources management.

3. RESULTS AND DISCUSSION

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The majority of the studied farmers (66.4%) were in the 40-70 age range. The average age of farmers was 49.1 years, indicating a relatively high dispersion of "farmers' age" data. In terms of education, the respondents were categorized as follows: illiterate (about 19%), elementary literacy (22.8%), middle and high school literacy (24.2%), high school diploma (25.5%), and bachelor's degree or higher (8.5%). On average, farmers had nearly 28 years of agricultural experience. All respondents were married and their average family size was about 5 people. According to the research findings, in terms of social participation, the respondents were categorized as follows: membership in rural cooperatives (24.8%), membership in the Islamic Village Council (3.4%), membership in Basij groups in neighborhoods (7.4%), and about 64.4% of farmers were not members of any rural organization. The average area under cultivation by each of the studied farmers was 8.34 hectares and according to farmers, their average annual agricultural income was about 10 million Tomans. In terms of the type of water resource, the majority of respondents (47.7%) used semi-deep wells to irrigate their farms, about 45% used rivers, and about 7% used deep wells. About the type of irrigation system, most of the studied farmers (92.6%) used traditional irrigation methods, and about 7% used modern ones. Findings showed that about 75% of the respondents used earth ditch and 24% used cement canals to transfer water to farms. The majority of respondents (75.2%) had access to water to irrigate their fields at certain times (irrigation time). In terms of irrigation time during the day, 50.3% of farmers irrigated their fields in the morning, 8.1% in the afternoon, 24.8% in the evening, and 16.8% at night. According to the research findings, only 10% of the respondents had used credit facilities to create or modernize their farm irrigation system during the last ten years. Using a five-point Likert scale (too little = 1 to too much = 5), it was evaluated to what extent the respondents faced water shortage and the results showed that the majority of farmers (90%) suffer water shortage in their farms too much (Table 2). In terms of participation in various extensional programs and activities, participation in water resources management workshops had the highest priority although about 64% of farmers had not yet participated in any extensional programs and activities (Table 3).

Table 2. Distribution of frequency percentage of respondents according to their exposure to water shortage

water shortage	Frequency	Valid percentage
Very much	117	78.5
Much	18	12.1
Medium	14	9.4
Low	0	0
Very little	0	0
Total	149	100

Table 3. Prioritize extension programs and activities according to the extent of farmers' participation in them

	Frequency	Valid percentage
None	95	63.8
Water Resources Management Workshops	28	18.8
Media	17	11.4
Farm Day	5	3.4
Exhibitions and shows	4	2.7
Total	149	100

The application of measures related to sustainable water resources management in agriculture, as a dependent variable, was assessed using 26 items. As seen in Table (4), four measures of "to plant crops on the appropriate date", "to use modified seeds with less water requirement (Mihan, Pishgam, etc.)", "to control the entry of human wastewater into water resources or water transmission canals", and "to try to optimally use water on the farm" were mostly used by farmers. While the measures of "to perform regular soil and water testing", "to use pressurized irrigation", "to use polyethylene pipes on the farm to transfer water", and "to not irrigate in hot and windy conditions" were less used by farmers. Ten items were used to investigate the effective agronomic factors in sustainable water resources management in agriculture. The results showed that "to observe crop rotation", "timely and correct weed control", and "to use wheat varieties with less water requirement" were the three important agronomic factors with the highest priorities from the farmers' point of view. To study the economic factors in sustainable water resources management in agriculture, 9 items were used. The results showed that "the farmer's financial capability to finance the use of modern irrigation systems", "to reduce the costs of using modern irrigation methods", and "to increase energy prices as a complement to water input in groundwater" were the important economic factors with the highest priorities according to the respondents. Five items were used to examine the social factors affecting sustainable water resources management. "To use knowledge, traditions and local rules for agricultural water management", "to establish coordination between government organizations and non-governmental organizations in agricultural water management", and "public participation in all stages of decision-making, implementation, and maintenance of agricultural water management projects" were the three most important social factors from the respondents' point of view.

Effective policy and institutional factors in sustainable water resources management in agriculture were investigated using 13 questions. "To obstruct unauthorized wells", "to enforce regulations and standards for agricultural water use", and "to impose fines on unauthorized harvesters" were three factors with the highest priorities for respondents. Effective educational-extensional factors in sustainable water resources management were studied using 11 questions. The results showed that the three top educational-extensional factors were "to broadcast educational videos on sustainable water management on TV", "to use text messages and mobile phones to send educational materials related to sustainable water resources management", and "to encourage farmers to participate in water resources management training classes". Finally, using ten items, farmers' attitudes toward sustainable water resources management were assessed. The results showed that according to the respondents, the following three items had the highest priorities: in my opinion, the water crisis in our region is an acute problem in the agricultural sector; In my opinion, agricultural water resources are limited and should be saved; and In my opinion, without the collective participation of farmers, it is not possible to properly manage water resources. Other priorities in each group are listed in Table (5).

Table 4. Ranking of the applied actions related to sustainable water resources management by farmers

Items	M *	SD	CV	Rank
To plant crops on the appropriate date	3.75	0.88	23.47	1
To use modified seeds with less water requirement (Mihan, Pishgam, etc.)	3.74	0.88	23.53	2
To control the entry of human wastewater into water resources or water transmission canals	2.38	0.61	24.60	3
To try to optimally use water on the farm	3.55	0.91	25.63	4
To use modern irrigation systems to reduce costs	3.51	0.94	26.78	5
To observe legal limits in the construction of wells	3.36	0.98	29.17	6
To cover irrigation ditches (cement, etc.)	3.43	1.02	29.74	7
To record the costs of water supply and irrigation	2.82	0.86	30.50	8
To control groundwater pollution	3.28	1.01	30.79	9
To maintain irrigation equipment	3.29	1.02	31.00	10
To plan to store the excess water of qanats, etc. in winter	3.38	1.11	32.84	11
To prevent the entry of animal wastes into water resources or water transfer canals	3.20	1.06	33.13	12
To select the cultivation pattern appropriate to the available water	3.32	1.11	33.43	13
To use smart water meters in wells	2.24	0.75	33.48	14
To control the growth of weeds in the field using non-chemical methods such as weeding and grazing	3.19	1.07	33.54	15
To reduce the use of chemical fertilizers and pesticides on the farm	3.09	1.08	34.95	16
To use water-storage pools on the farm	3.16	1.12	35.44	17
To attempt to use government facilities in the field of sustainable agricultural water management	3.09	1.11	35.92	18
To plan rainwater storage through the implementation of watershed management plans	3.30	1.19	36.06	19
To irrigate the farm in the afternoon and evening	3.09	1.13	36.57	20
To perform protective plowing to control soil moisture and prevent soil erosion	2.93	1.12	38.23	21
To reuse wastewater	2.99	1.27	42.47	22
To perform regular soil and water testing	1.82	0.8	43.96	23
To use pressurized irrigation	1.93	0.85	44.04	24
To use polyethylene pipes on the farm to transfer water	2.65	1.18	44.53	25
To not irrigate in hot and windy conditions	2.70	1.21	44.81	26

Table 5. Ranking of items related to factors affecting the sustainable water resources management from the farmers' point of view and their attitudes towards it

Factor	Item	M *	SD	CV	Ra
Agronomic	Timely and correct weed control	3.72	0.76	20.43	1
	To observe crop rotation	3.95	0.88	22.28	2
	To use wheat varieties with less water requirement	3.67	0.87	23.71	3
	To prevent the accumulation of waste in the water channel	3.61	0.97	26.87	4
	To reuse wasted and excess water	2.96	0.83	28.04	5
	To reduce the number of plows	3.6	1.02	28.33	6
	To consolidate lands to prevent water wastage	2.02	0.84	41.58	7
	To store water in water-storage ponds during rainy seasons	2.45	1.05	42.86	8
	To fertilize and irrigate together	2.38	1.06	44.54	9
	To plant crops early to escape drought and stress	1.96	1	51.02	10
Economic	The farmer's financial capability to finance the use of modern irrigation systems	3.56	1.04	29.21	1
	To reduce the costs of using modern irrigation methods	3.66	1.08	29.51	2
	To increase energy prices as a complement to water input in groundwater	3.39	1.07	31.56	3
	To reduce subsidies for agricultural inputs	3.43	1.11	32.36	4
	To increase water rights (water price)	3.34	1.18	35.33	5
	To ration the production of crops based on the availability of water	3.16	1.13	35.76	6
	To ration local water supply	3.36	1.21	36.01	7
	To enhance the credit facilities received by farmers to improve their irrigation system	3.04	1.16	38.16	8
	To use agricultural insurance	2.69	1.12	41.64	9
Socialژ	To use knowledge, traditions, and local rules for agricultural water management	3.79	0.88	23.22	1
	To establish coordination between government organizations and non-governmental organizations in agricultural water management	3.91	0.96	24.55	2
	Public participation in all stages of decision-making, implementation, and maintenance of agricultural water management projects	3.55	0.99	27.89	3
	To form non-governmental organizations such as Water Use Associations (WASs) to manage and monitor the optimal use of water resources	3.53	1.11	31.44	4
	Group cultivation through land consolidation	2.04	0.79	38.73	5
Policy-institutional	To obstruct unauthorized wells	4.26	0.77	18.08	1
	To enforce regulations and standards for agricultural water use	4.12	0.79	19.17	2
	To impose fines on unauthorized harvesters	4.06	0.78	19.21	3
	To observe legal limits and distance required between wells	4.10	0.87	21.22	4
	To extend the repayment system of the credits granted for the use of modern irrigation systems	4.12	0.91	22.09	5
	To support private sector investment in agricultural water resources management	4.03	0.9	22.33	6
	To facilitate regulations for obtaining bank loans for the use of modern irrigation systems	4.06	0.92	22.66	7
	To establish coordination between government organizations related to water affairs	3.86	0.88	22.80	8
	To allocate long-term funds for the restoration and rehabilitation of water resources by the government	3.89	0.96	24.68	9
	To prevent the uncontrolled increase of unauthorized wells	3.92	1	25.51	10

Factor	Item	M *	SD	CV	Ra
	To install smart water meters on wells	3.60	1.01	28.06	11
	To reduce the interest rate of credits granted for water resources management	3.74	1.1	29.41	12
	To electrify diesel engine water pump	2.32	1.16	50.00	13
Educational-extensional	To broadcast educational videos on sustainable water management on TV	4.28	0.81	18.93	1
	To use text messages and mobile phones to send educational materials related to sustainable water resources management	4.28	0.82	19.16	2
	To encourage farmers to participate in water resources management training classes	3.99	0.85	21.30	3
	To educate how to maintain and repair modern irrigation systems	3.94	0.94	23.86	4
	To visit wheat fields by experts and provide management solutions to reduce agricultural water consumption	3.97	0.99	24.94	5
	To visit successful pilot farms related to sustainable water resources management projects in agriculture	3.81	0.99	25.98	6
	To visit wheat fields with modern irrigation systems	3.46	1.09	31.50	7
	To distribute educational magazines and brochures in the field of optimal water resources management	3.22	1.15	35.71	8
	To hold training classes in the field of optimal water resources management in agriculture	3.3	1.21	36.67	9
	To hold extension training classes to acquaint farmers with the benefits of modern irrigation systems	3.21	1.18	36.76	10
	Skills and expertise of extension irrigation specialists in the field of sustainable water resources management	3.36	1.28	38.10	11
Farmers' attitudes towards sustainable water resources management	In my opinion, the water crisis in our region is an acute problem in the agricultural sector.	4.24	0.75	17.69	1
	In my opinion, agricultural water resources are limited and should be saved.	3.95	0.77	19.49	2
	Government oversight of water well drilling increases groundwater levels and thereby water resources	3.72	0.84	22.58	3
	In my opinion, without the collective participation of farmers, it is not possible to properly manage water resources.	3.77	0.87	23.08	4
	In my opinion, water resources can be used properly if farmers use the right cultivation pattern	3.77	1.01	26.79	5
	People are involved in preventing water pollution	3.6	1.07	29.72	6
	Agricultural water resources should be used in such a way that their quantities are kept unchanged in the long run, even if it means less production and less profit.	3.2	1.07	33.44	7
	In my opinion, using modern irrigation systems, with no special advantage for farmers, will impose additional costs on them.	2.74	1.04	37.96	8
	Traditional irrigation systems are easier to use than modern irrigation systems.	2.67	1.15	43.07	9
	I am ready to pay all the necessary expenses for setting up modern irrigation systems on my farm with no support from the government.	2.59	1.12	43.24	10

The correlation coefficient was used to investigate the relationships between the application of measures related to sustainable water resources management in agriculture and the studied variables. According to the correlation coefficients in Table (6), there are significant positive relationships between membership in rural organizations, the area under cultivation, income, agricultural, economic, educational-extensional, policy and institutional factors, and farmers' attitudes towards sustainable water resources management and the application of measures related to sustainable water resources management. It should be noted that there is no significant relationship between the variables of age, education, family size, agricultural experience, and social factors and the application of measures related to sustainable water resources management in agriculture. The stepwise multiple regression analysis was used to investigate the effect of the studied independent variables on the rate of farmers' application of measures related to sustainable water resources management. As seen in Table (6), the results of regression analysis showed that the variables of economic factors, farmers' attitudes toward sustainable water resources management, educational-extensional, social, and agronomic factors explained 63% of the variance of the dependent variable. According to the beta coefficient, the variable of economic factors had a greater share and role in explaining the dependent variable than other variables. It should be noted that for all independent variables, the value of the tolerance index was >0.1 and their VIF value was <10. Also, for all variables, the Durbin–Watson statistic was obtained to be 1.66. Since the obtained value was between 1.5 and 2.5, it can be ensured that there was no autocorrelation between the variables.

Table 6. Relationship between the studied variables by applying proceedings related to sustainable management of agricultural water resources

	Coefficient used	**correlation coefficient**	**Significance level**
Agronomic factors	Spearman	0.552**	0.000
Economic factors	Spearman	0.701**	0.000
Educational-extension factors	Spearman	0.547**	0.000
Policy-institutional factors	Spearman	0.194*	0.01
Farmers' attitudes towards sustainable water resources management	Spearman	0.638**	0.000
Area under cultivation	Pearson	0.325**	0.000
Income	Pearson	0.271**	0.000
Membership in rural organizations	Spearman	-0.165*	0.044
social factors	Spearman	0.134	0.103
Age	Pearson	-0.016	0.851
Level of Education	Spearman	0.006	0.938
Number of family members	Pearson	0.067	0.42
Experience of agricultural activity	Pearson	-0.126	0.125

significance at the level of one percent, * Significance at the level of five percent

Table 7. Regression coefficients of variables affecting the sustainable management of agricultural water resources

	Variable	B	Beta	t	Sig
A	Constant	36.186	-	10.858	0.000
X_1	Economic factors	1.447	0.703	11.976	0.000
X_2	Farmers' attitudes towards water management	0.924	0.341	4.927	0.000
X_3	Educational-extension factors	0.451	0.210	3.268	0.000
X_4	social factors	-0.770	-0.181	-3.116	0.002
X_5	Agronomic factors	0.515	0.157	2.348	0.020
R=0.797	$R^2 = 0.635$		$R^2_{Ad} = 0.623$		

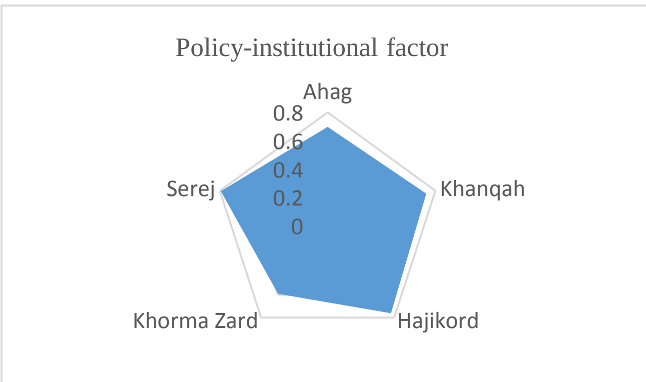
Assessment of the sustainability of agricultural water resources management from the respondents' point of view

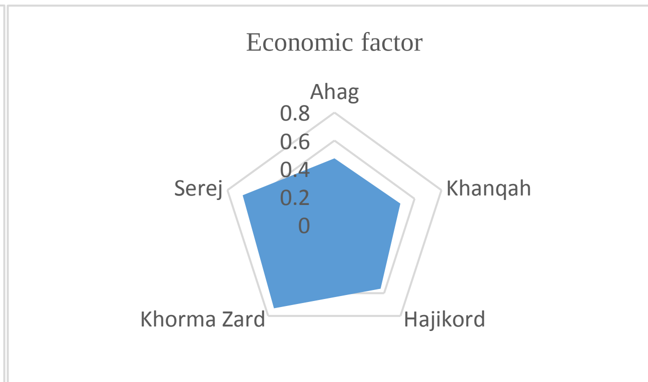
In the present study, to calculate the sustainability index in each of the dimensions, first, the studied indicators were normalized and then the resulting quantities were unscaled to relative values. To do this, the minimum and maximum values of each indicator were determined and their ranges were obtained. Then, the minimum value of each indicator minus its numerical value was divided by its range to obtain a relative unscaled value between zero and one. Finally, the obtained relative values for each indicator were averaged and the obtained value was considered the value of the sustainability index in each dimension. To convert quantitative values into qualitative ones, the five quality classes presented by Prescott-Allen's, as listed in the table below, were used.

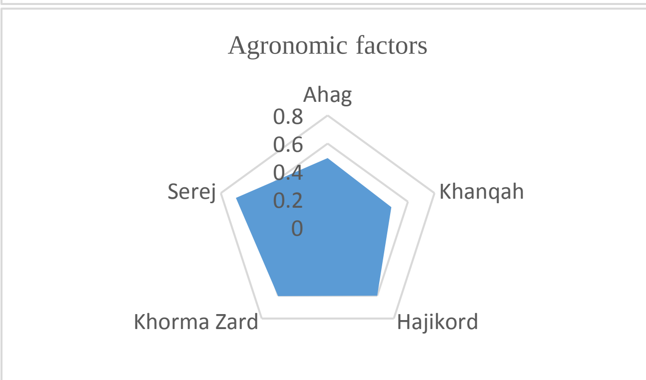
Table 8. Five Classes of Prescott Allen Stability Assessment.

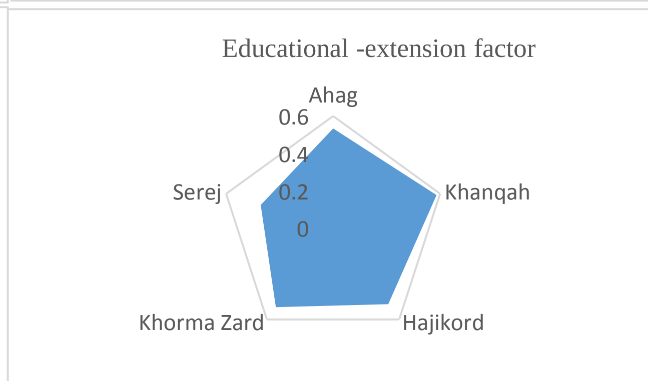
Condition	**Equivalent**	**Value**	**Rating**
Unstable	0-0.2	0-20	**1**
Potential instability (weak)	0.21-0.40	21-40	**2**
Medium	0.41-0.60	41-60	**3**
Potential stability (good)	0.61-0.80	61-80	**4**
Stable	0.81-0.1	81-100	**5**

Considering the results presented in Table 9 and Figure 1, Serej village with a score of 0.669 has the highest rank in terms of sustainable water resources management, followed by Khorma Zard village (a score of 0.625), Hajikord village (a score of 0.625), Khanqah village (a score of 0.577), and Ahaq village (a score of 0.546), respectively. Agronomic factors obtained the highest score in Serej village and the lowest one in Khanqah village. In terms of economic factors, Khorma Zard and Ahaq villages obtained the highest and lowest scores, respectively. In terms of social factors, Serej and Khanqah villages obtained the highest and lowest scores, respectively. In terms of educational and extensional factors, Serej and Khanqah villages obtained the highest and lowest scores, respectively. In terms of policy and institutional factors, Serej and Khorma Zard villages obtained the highest and lowest scores, respectively. The final *results of assessing the sustainability of water resources management among irrigated wheat farmers in Maragheh City showed that Serej village with the highest score and Ahaq village with the lowest score are the most and least sustainable villages in terms of agricultural water resources* management, respectively. From the perspective of irrigated wheat farmers in Maragheh City, the sustainability of agricultural water resources management was evaluated to be at a moderate level according to the total scores obtained for them. Moreover, the highest total score (0.715) was related to policy and institutional factors and the lowest one (0.507) was related to educational and extensional factors.









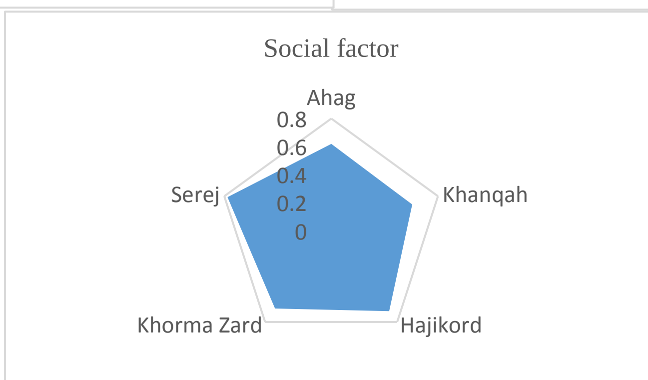


Fig. 1. Status of different dimensions of sustainability of water resources management of irrigated wheat farmers in Maragheh city in Iran.

Table 9. Status of different dimensions of sustainability water management from the perspective of wheat farmers.

Village	Agronomic factor	Rating	Economic factor	Rating	Social factor	Rating	Educational-extension factor	Rating	Policy-institutional factor	Rating	Total stability	Rating
Ahag	0.496	4	0.474	5	0.62	4	0.534	2	0.698	4	0.564	**4**
Khanqah	0.477	5	0.493	4	0.607	5	0.58	1	0.732	3	0.577	**3**
Hajikord	0.599	3	0.56	3	0.705	2	0.499	4	0.762	2	0.625	**2**
Khorma Zard	0.602	2	0.733	1	0.681	3	0.519	3	0.594	5	0.6258	**2**
Serej	0.687	1	0.686	2	0.776	1	0.406	5	0.793	1	0.669	**1**
Total	0.572	-	0.589		0.677	-	0.507	-	0.715	-	0.612	-

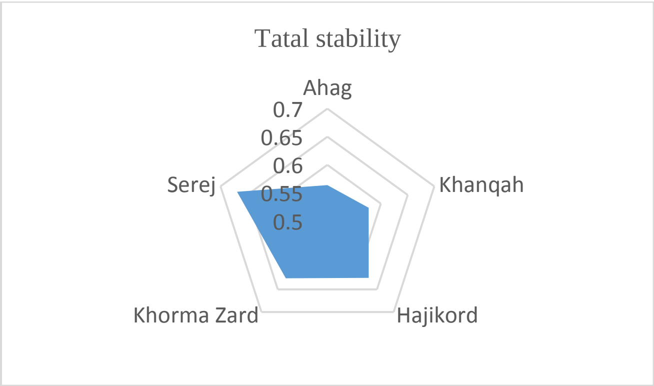


Fig. 2. Status of Sustainability of water resources management of irrigated wheat farmers in Maragheh city in Iran.

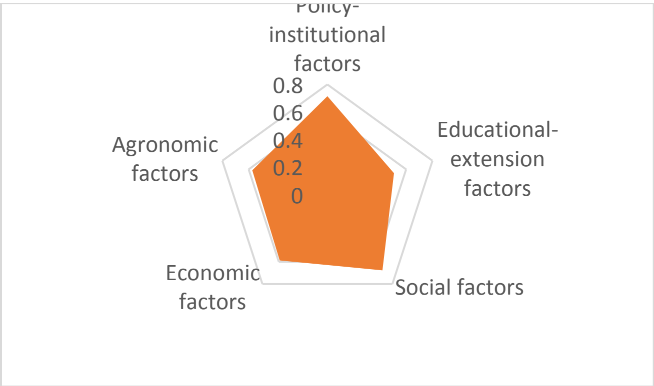


Fig. 3. Sustainability of water resources management factors of irrigated wheat farmers in Maragheh city in Iran.

4.CONCLUSIONS

Sustainable water resources management requires the application of some measures, each of which can significantly contribute to increasing water use efficiency and sustainability of this vital resource. The results showed that in the villages of Maragheh City, farmers moderately applied measures related to sustainable water resources management. To confirm this finding, Ganji *et al*. (2017), Rezanejad (2016), Afshari (2015), Rahimi (2015), and Samian (2013) also showed that farmers have moderately applied measures related to sustainable water resources management. In the present study, a positive and significant relationship was observed between the area under cultivation and agricultural income with the application of measures related to sustainable water resources management, which is consistent with the results of the studies by Afshari (2016), Akhavan *et al*. (2012), Pezeshki Rad *et al*. (2011), and Omani (2010). In fact, large farmland owners are more likely to take measures related to sustainable water resources management. Moreover, the greater area under cultivation provides a good basis for the optimal allocation of capital and its efficient use on the farm. Large farmland owners also have higher incomes due to the optimal use of technology and specialized knowledge. So, with the increase in the area under cultivation and thereby the increase of farmers' incomes, they are more willing to apply measures related to sustainable water resources management. According to the results, it was found that there was a significant negative relationship between farmers' membership in rural organizations and the application of measures related to sustainable water resources management. Local communities have important information, experiences, and ideas that can be useful in raising farmers' awareness and solving water resources management problems. Despite the importance of the issue, the results of the present study indicated a negative and significant relationship between membership in rural organizations and the application of measures related to agricultural water resources. So, it is necessary to prioritize the solution of the problems faced by rural organizations such as rural cooperatives, production cooperatives, and Water User Associations (WUAs) in the programs of regional and provincial managers.

Given that farmers' decision to apply measures related to water resources management depends directly on their psychological factors, it is important to determine what the attitude of farmers towards water resources is. Attitude, as one's positive or negative evaluation of performing the behavior, is made up of three cognitive, emotional, and behavioral elements and is the main factor in behavior change. Many researchers consider attitude to be the main factor in behavior change. According to them, if people change their attitudes, their behaviors will also change. In this regard, one of the results of the present study was about the relationship between farmers' attitudes toward water resources management and the application of measures related to sustainable water resources management. According to the results, there was a positive and significant relationship between farmers' attitudes and the rate of application of measures related to sustainable water resources management. In other words, the more favorable farmers' attitudes towards the optimal water resources management in the study area, the higher the rate of their application of measures related to sustainable water resources management. Moreover, according to regression analysis results, this factor was identified as one of the effective factors in sustainable water resources management in agriculture. This result was consistent with the results of research by Eidi et al. (2015), Afshari et al. (2015), Nouri et al. (2013), and Chartzoulakis and Bertak (2015). Raising farmers' awareness by paying attention to various promotion mechanisms can be effective in improving farmers' attitudes towards sustainable water resources management and increase their application of measures related to sustainable water resources management.

The results of the correlation coefficient test and regression analysis showed that agronomic factors had a positive and significant effect on better and more sustainable water resources management in agriculture. This result was consistent with several studies such as those by Samian (2013), Akhavan et al. (2012), and Pezeshki Rad et al. (2011). In this regard, increasing the use of modified seeds with less water requirement, using modern tillage methods, and minimizing tillage operations to prevent damage to soil structure, increase productivity and maintain soil moisture can be useful in sustainable water resources management. Land consolidation also plays a key role in the optimal and sustainable water resources management in agriculture. Therefore, national and regional managers and authorities must consider the adoption of those policies and plans intended to increase public participation in the implementation of land consolidation projects, such as culturalization and increase of farmers' financial capability, etc.

According to the research findings, there was a positive and significant relationship between economic factors and the application of measures related to sustainable water resources management in agriculture. This is consistent with the research by Panahi *et al*. (2012) and Mohammadi *et al*. (2009). Supporting the agricultural sector and farmers in most countries of the world is a priority for policymakers. Having financial capability and credit is the first step and the necessary background for the implementation of many measures related to sustainable water resources management. For example, recommending farmers to use modified seeds with less water requirement or to implement sustainable water resources management methods requires the use of agricultural implements, so it is necessary to have the financial capacity. The policymakers are suggested to provide the ground for granting loans with low-interest payments, a repayment period, and a long rest period commensurate with the conditions of farmers. Also, the government is suggested to allocate funds to farmers, especially low-income farmers, to help them in the construction and restoration of irrigation networks, the use of modern irrigation technologies, etc. However, using government funds to improve irrigation systems can be considered a suitable solution for optimal water resources management if these funds are actually spent on the use and improvement of irrigation systems, otherwise, the financial resources will only be wasted. So, it is required to continuously and accurately monitor this process. This is doubly important because most farmers in the study area have low financial capability.

The results of the present study indicated a positive and significant relationship between educational-extensional factors and sustainable water resources management. According to regression analysis, this variable was identified as one of the positive factors effective in increasing the application of measures related to sustainable water resources. Various studies such as Eidi *et al*. (2015), Rezanejad (2016), Nouri *et al*. (2013), Amirkhani *et al*. (2010), and Thi Lan Huong *et al*. (2017) have emphasized the positive correlation between educational-extensional factors sustainable water resources management in agriculture and shown that farmers who receive the necessary information and training in the field of water resources management and cover their educational needs in this field to some extent, apply most of the measures related to sustainable water resources management. Therefore, it can be useful to provide any education on sustainable water resources management, such as training workshops, field observations, information, and raising of awareness in the form of a quarterly journal, magazine, lecture, or via public media (radio, television, etc.). Also, since the majority of farmers currently use social networks, the potential of these networks can be used to the fullest. The use of these networks requires a group of experts in the Ministry of Agriculture Jihad to prepare purposeful and scientific video clips and educational materials appropriate to the culture of the regions and in the dialect of each region (in Turkish in the study area) to be used by illiterate people. Therefore, it is required to make the necessary plans and arrangements in this regard.

The research findings indicated the significant role of policy and institutional factors in sustainable water resources management. Therefore, the government and the organizations in charge of agricultural water resources are suggested to approve useful and effective standards and codes to improve water consumption, strictly prevent the drilling of unauthorized wells, and eliminate existing unauthorized wells cautiously. Also, inspections and supervision of the exploitation and optimal use of water in the agricultural sector, such as the volumetric water delivery to the agricultural sector, the installation of smart water meters, and the establishment of tariffs or deterrent fines for over-standard consumption should be the priorities of the relevant plans. The results of assessing the sustainability of agricultural water resources management in the study area showed that it was at the moderate level and among the studied villages, Serej and Ahaq villages were the most sustainable and unsustainable villages in terms of water resources management, respectively. Therefore, any program regarding sustainable water resources management should be first implemented in unsustainable villages (Ahaq, Khanqah, and Hajikord) in the study area and according to the results of regression analysis, the economic support of farmers should be a priority in action plans.

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